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ABSTRACT

This paper describes a project underway at the California State Department of Education to develop a model curriculum for computers in education. The first part of the paper describes the unique aspects of computers in education, including their potential for efficient transmission of information, the possibilities for teaching subject matter outside the regular curriculum, their interactive properties, the fact that they allow for personalized feedback and pacing, and the potential for simulating learning contexts that are otherwise not feasible for schools. The role of the state is then described as removing barriers to the effective implementation of computers in schools. The background and rationale for the model curriculum project, the development process, and a clarification of the purposes, organization, and contents of the model curriculum document are then described. The five major "strands" of the document are as follows: (1) operation of computer systems, (2) computer applications, (3) developing thinking skills through programing, (4) computer science, and (5) the societal impact of computers. (TE)

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THE CALIFORNIA MODEL CURRICULUM FOR COMPUTERS IN EDUCATION

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I'll be talking today about a project that we have underway at the State Department of Education. But to put this project into some context, it might be helpful to say a few words about the current status of computers in the schools, why this so-called revolution is so unique, how the state fits into this situation, and how the model curriculum project came to be in light of our perception of the state's role.

Unique Aspects About Computers in Education

Perhaps the most unique aspect about computers in education is that the influx of computers into the schools has been a grassroots phenomenon, and not a top-down innovation. The most common manner in which computers appear today in the classroom is due to the efforts of a particular teacher who has become interested in their educational applications and has figured out ways in which to use them in the curriculum. This is in contrast to the more traditional approach of a top-down innovation, where, for example, the state or perhaps a district mandates a particular learning approach (e.g., language labs) without proper training, without widespread school and community support, and with no sense of integration within the curriculum.

A second aspect about computers in the schools is that the grassroots nature of the movement has generated a tremendous amount of enthusiasm about teaching in general. In the face of low salaries, not altogether ideal working conditions, and other barriers, teachers tend to be highly enthusiastic about the use of computers in their classrooms. I believe this is translating into a greater excitement about teaching in general than we have seen for a long time.

Finally, unlike the influx of TV, language labs, and other so-called technological innovations, computers appear to be here to stay. Assuming current problems such as lack of sufficient in-depth training and lack of innovative and high quality software can be addressed, computers have the capacity to revitalize the educational system.

What Is It About Computers That Makes Their Use in Education So Exciting?

1. They give students the capacity to acquire information efficiently, and through another medium. In this process, computers teach valuable skills that will help students live and work in the "information society."

2. They present possibilities for teaching subject matter outside the regular curriculum, and in some cases, beyond the specific knowledge of the teacher.

3. They provide feedback to the individual learner, allowing pacing according to the learner's capability.

4. They open up the possibility for learning that is inherent in simulations that might otherwise be too costly or dangerous.

EA 017 124

5. Through experiences such as programming, they develop the capability of the learner for more logical thinking and analysis skills.

Role of the State in Increasing the Effective Use of Computers in Education

So, where does the state fit into this apparent rosy picture of computers in education? Actually, the picture is not quite so rosy, at least not yet. There are real implementation problems to be solved in the areas of training, hardware, software, and curriculum development. In addition, equity considerations are looming on the horizon as a major area of concern.

We see the role of the state as one of addressing equity and other such problems that act as implementation barriers to effective utilization of computers in education. Another problem area, in addition to equity and which is the subject of today's session, is that of effecting whatever changes are needed in curriculum so that computers can serve as effective learning tools to promote the educational goals and priorities of the schools.

The Model Curriculum for Computers in Education

We felt that one of the most useful things the state could do is to provide schools with a rich and varied source of ideas for improving the general educational level of the schools through the use of computers and computing. Thus, we are in the process of developing a computer education model curriculum. Its final title will be "Computers in Education: Goals and Content."

Background and Rationale for Project

Many groups recently, most notably the National Commission on Excellence in Education, have called for a refocusing on the "very study" of education--the core curriculum for areas often referred to as the New Basics (English, math, science, social studies, and computer studies). In California, the Superintendent has made the development of a "core curriculum"--substantive statements of expectations for student knowledge, skills, and concepts--a priority mission for the State Department of Education.

It is our hope that such a series of statements will help mobilize the educational system to set and achieve a high level of expectations for students. The intent here is to raise both the floor and ceiling of student achievement--not produce yet another "minimum" proficiency. It is also our hope that strong statements will help drive other parts of the system. For example, internally, it could drive development of handbooks, frameworks, and testing. Externally, it could drive teacher training, local curriculum, and textbook content.

Finally, another rationale for this project is a mandate in SB 813 for the State Board of Education upon the advice of the Department, to adopt a model curriculum in computer studies for students in grades K-12.

Process of Development

The content of the document was produced by a small working committee, with representatives from schools, district and county offices, and TEC Centers. The review process contains several steps. We now have a good working draft of the document. The next step will be a broad field review of perhaps 40 individuals.

In addition, informal speaking engagements such as this are excellent ways for us to get feedback. We expect to publish the document by around February. A usable draft should be available just after the first of the year.

What the Curriculum Is and Isn't

This curriculum provides the state's perspective on the uses of computers in education and what knowledge, skills, and values all students should acquire about computers by the time they graduate. The document takes the point of view that while there clearly will be different levels of expertise developed in each skill area, all students should be provided the opportunity to use the power of computers in different ways and in many different subject areas.

The curriculum is a document intended for all educators. However, it should be most useful for purposes of driving local curriculum development. This is not a scope and sequence from the state. Such an effort should be locally developed. Moreover, this is not meant to be a rigid document. As technology changes, it too must change.

The curriculum also serves as a vehicle to send certain messages regarding the uses for computers in schools. For example:

- Extensive hands-on experience must be provided for all students at all grade levels
- The most beneficial experiences are those in which the student has control over the computer
- The use of computers should be integrated throughout the curriculum at all grade levels
- All students should learn to program the computer to some level of proficiency
- The computer provides a powerful and direct way to teach critical thinking and problem-solving skills

Finally, the document itself serves as the state's definition of computer literacy. Computer literacy is not defined specifically as a term in the document. Rather, by laying out a broad array of skills and knowledges, it covers all the topics that could conceivably be bundled under the rubric of computer literacy. Any educator wishing to design a computer literacy program will find all the relevant content in the model curriculum.

Organization of the Document

The document is deliberately organized to provide for flexibility in local curriculum development. It doesn't specify exactly what should be taught when. The five major sections, or strands, should be thought of as running in parallel, with a given use of computers addressing skills and knowledge from several strands. Skills in initial strands are not intended to be completely addressed before skills in other strands are initiated. The strands are:

- Operation of Computer Systems
- Computer Applications

- Thinking Skills Through Programming
- Computer Science
- Societal Impact of Computers

Content of the Model Curriculum

a. Operation of Computer Systems

This strand deals with skills and knowledge students require in order to successfully and safely operate a computer system. It is important that the content of this strand be taught in a hands-on fashion in conjunction with material from other strands.

Thus, young students should be learning to identify and use alphabetic and numeric keys in the context of using instructional software or a simple programming language. These experiences should begin as early as possible in a student's educational career, preferably in the elementary grades. Students need to acquire knowledge and skills in the following areas:

(1) Keyboarding skills

(2) Systems components--for example, knowledge of how a system is put together, what role various storage devices play, how telecommunications systems work

(3) Computer operation--in essence the ability to perform basic tasks with software, e.g., load, list, erase, break, etc.

(4) Computer applications--this is dealt with quite substantively in the next strand. In this strand, the intent is to have students acquire an awareness level of knowledge about such applications as word processing, spreadsheets, data base and file managers, graphics programs, programming languages, and when they might be most useful.

b. Applications

This strand has to do with using computers as a tool to accomplish certain tasks. We don't regard applications in the narrow sense as data base management programs, spread sheets, or word processing, but rather as a continuum from Computer Assisted Learning (CAL) material through these applications I just mentioned to programming itself. That is, the computer can be applied in an educational setting in all of these ways.

Underlying this continuum is the idea of student control over the computer. At one extreme, drill and practice, as one form of CAL, represents an activity in which the student essentially has no control over content or presentation strategies. Formal programming, on the other hand, puts the student fully in control of the computer and its operation. Other types of applications lie somewhere between these extremes; the level of control depends on the specific application.

In each of the general classes of applications I will mention, there is a broad range of skills to be taught and the software that can be used ranges from the relatively simple to very complex. The particular subject

areas to which they are applied and the specific software that will be used will depend upon the level of sophistication of the teacher and the developmental level of the students. The following are the general classes of applications:

Computer Assisted Learning (CAL)

The curriculum describes CAL materials in terms of drill and practice, simulations, tutorials, and educational games. The point is made that all students should have as many opportunities as possible to use these applications throughout the curriculum. Furthermore, in planning CAL activities, in addition to selecting materials with the appropriate content and level of difficulty, it is important to consider what critical thinking skills students have to employ in working the materials, and the level of control they have over the computer and the educational content.

Word Processing

Electronic Spreadsheets

Data Base Managers

c. Thinking Skills Through Programming

This model curriculum is based on the premise that all students should be provided with the opportunity to learn the fundamentals of computer programming. Among the most important reasons for this premise are that:

(1) Programming puts the student in control of the computer, providing a sense of power and accomplishment and enhancing self-esteem.

(2) Programming provides a very direct method of teaching a wide range of critical thinking skills, problem-solving skills, and communication skills. It is these which we feel are among the most enduring types of skills that are acquired throughout schooling.

(3) Programming a computer provides unique insights into the relationship between people and machines, thus demystifying the machine.

(4) As with language arts and reading, once a student has mastered some elementary thinking skills, they can be put to work in other areas of the curriculum.

The skills and examples in this strand are generic in nature and are intended to make explicit the primary purpose for teaching programming--the acquisition of a set of problem-solving skills and strategies that are computer language independent and applicable to problems in a wide range of subject matters. An important concept in implementing this curriculum is that each of the generic problem-solving skills should be addressed many times in different content areas and in ever more complex situations.

The following are the problem-solving skills described in the model curriculum:

(1) Describing the problem in your own words
(2) Breaking down the problem into manageable pieces

(3) Developing algorithms
(4) Anticipating outcomes and unforeseen events
(5) Generalizing a problem solution
(6) Debugging
(7) Communication skills

In teaching these thinking skills through programming, there is clearly a set of programming skills per se that have to be taught. These are primarily language independent, although some are not possible at all in some languages and others much easier in some languages than in others. Examples are:

(1) Define and use simple procedures and subroutines.
(2) Use control structures for simple iterations (loops and recursions) and choices (branches).
(3) Define and use numeric and string variables.
(4) Design appropriate error trapping routines.

A fuller list is provided in the model curriculum itself.

d. Computer Science

This section of the curriculum describes content that is primarily elective in nature. In general it would be taught in a formal computer science course. It is not suggested that all, or nearly all, students would be capable of mastering this content or of benefiting from it. It is important to point out, however, that this material overlaps with that in other strands, and that what is covered with students should be dependent on their skills and interests, not on some arbitrary division of content.

Skills and Knowledges

- Understand the use of high-level languages, compilers, and interpreters
- Understand the use of assembly language and assemblers
- Understand number systems used in computers
- Understand various data representation schemes
- Understand how data is stored and accessed in memory and on discs
- Understand the basic architecture of computers
- Understand elementary electronic circuit design principles

e. Societal Impact

As with all areas of the curriculum, this one should be covered in a wide variety of settings and subject matters. While the proposed content is computer related, it cuts across subject matters; the major headings have been chosen to reflect this. For example, while the ethical considerations surrounding copyrighted software should clearly be dealt with directly in the context of computer use, they also have a place in social studies units devoted to societal ethics in general.

The skills and knowledges in this strand fall into the following areas:

(1) Ethics and Values
(2) Impact of Computer Technology
(3) History of Computers and Computing
(4) Technological Consumer Skills
(5) Vocational/Career Information